Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

LIBRARY U.S. FOREST SERVICE BERKELEY

PACIFIC NORTHWEST

U. S. FOREST SERVICE

Research Note

FOREST AND RANGE EXPERIMENT STATION · U.S. DEPARTMENT OF AGRICULTURE · PORTLAND, OREGON

PNW-49

March 1967

RADIATION SAMPLING IN A MOUNTAINOUS ZONE

by

William B. Fowler, Meteorologist

Within a broad area of similar climate, it is commonly accepted that a single station measurement of incoming solar radiation can be representative of conditions for a reasonable distance. In other areas where climatic change is rapid, extension of single station measurements over even short distances may be suspect. Within the Western United States, rapid climatic changes are typical.

A preliminary investigation of input variation and sampling intensity was made during the summer of 1963 in a watershed east of the Cascade Range crest in Washington State. Radiation sensors (pyranometers) (fig. 1) were calibrated (including recorder error) to within 5 percent of a standard Eppley pyranometer. All sensors recorded within 2 percent of each other.

With the exception of one lower elevation site (2,500 feet), all stations were within a 5,000- to 7,000-foot range with unobstructed hemispheric view. The lower elevation site was included in the graphs (figs. 2 and 3) and subsequent computations without correction for elevational effects.

Figure 1.--*Field installation of radiation sensor used.*

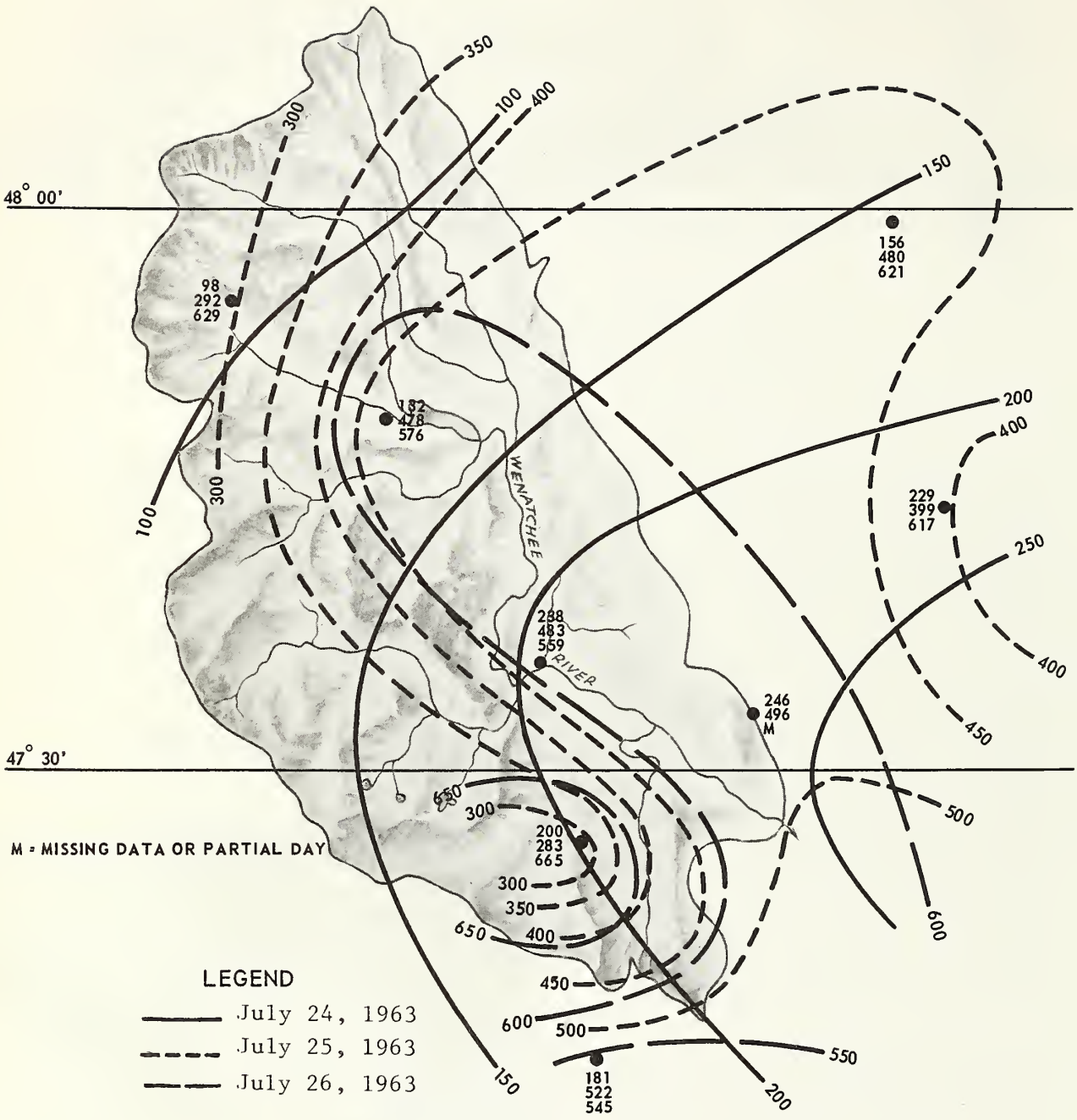

Figure 2.--*Three-day input pattern of total solar radiation ly. day^{-1} for July 24-26, 1963.*

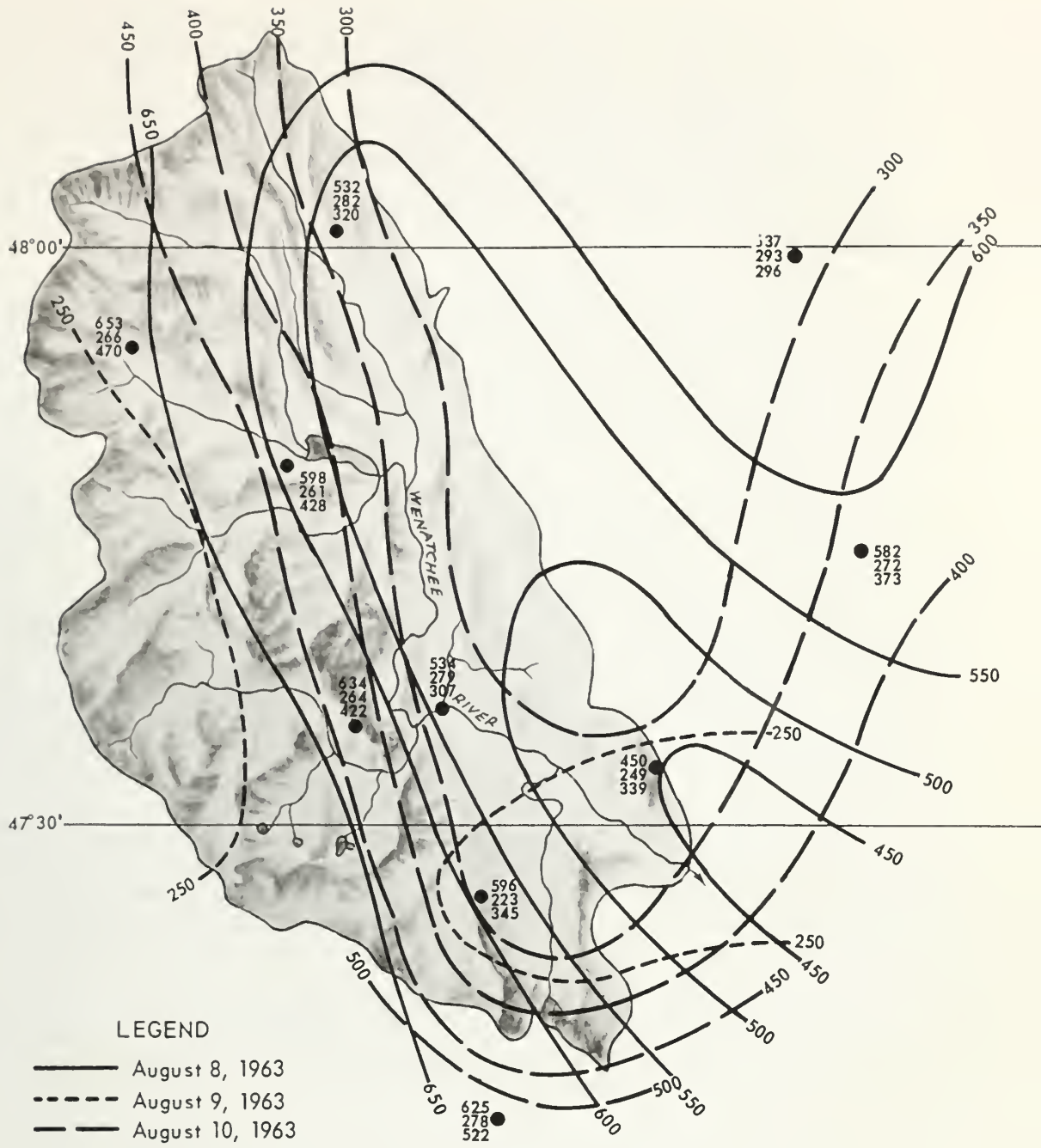

Figure 3.--*Three-day input pattern of total solar radiation ly. day^{-1} for August 8-10, 1963.*

The input data for two 3-day sequences (figs. 2 and 3) reflect the changing patterns of cloud development and movement within or across the watershed area. July 24 (fig. 2) represented a situation of generally low radiative input but with gradual dissipation of cloud cover with distance east from the Cascade Range crest. This is an expected and frequently occurring pattern. More marked clearing to the east was seen on July 25. On July 26 the weather system had passed through the area; all sensors showed high input values, and gradient was small over the entire watershed area.

August 8 (fig. 3) represented another commonly occurring pattern. Cumulus clouds developed over the eastern segment of the watershed lowering input values compared with the western segment. A large change to much lower overall values and reduction in gradient was shown on August 9 with passage of a weak storm. The residual effects of this storm were seen in the eastern section on August 11.

These particular days were chosen from a larger group on the basis of most complete data. There were periods when the input patterns were either more consistent or more erratic than those shown.

Table 1, based on data in figures 2 and 3, indicates numbers of randomly located stations required to determine mean daily input radiation value for 5- and 10-percent confidence intervals at the 95-percent level of probability. Increasing probability above the 95-percent level, or increasing confidence interval, increases by a large factor the number of required stations. For example, each 50-percent increase in confidence interval will increase sampling density by a factor of 4.

Other statistical procedures can be used to recalculate sample size, such as pooling within-day variance. Also, other sampling designs may be adopted to reduce actual numbers of required instruments. However, the fact that an enormous amount of natural variation exists in input radiation cannot be minimized.

The need for increasing numbers of stations in areas of rapid climatic change can be seen, especially if any realistic relationship between input energy to physical processes (i.e., evapotranspiration) is to be determined or utilized.

This need has been expressed for other areas as well. Drummond,[1/] writing of UNESCO's program for the development of arid lands, states, "the main necessity here is for the establishment of radiation climatologies, representative within the limitations of the purpose in mind, from widespread observational networks at which robust and relatively inexpensive instruments are preferred to only a few selected measurement series, even if the latter are of a more precise nature."

[1/] Drummond, A. J. Radiation and the thermal balance. Climatology: Reviews of Research, 1-20. UNESCO. 1958.

Table 1.--Number of stations for sampling radiation intensities (on the basis of figures 2 and 3) by selected 1963 dates

Date	Number of stations used	Input radiation values			Variance s^2	Number of stations required when sampling error (95-percent probability) is	
		Mean	Maximum	Minimum		10 percent of mean value	5 percent of mean value
		ly. day^{-1}					
July 24	8	185	246	98	2,846	33	133
July 25	8	429	522	292	8,863	19	77
July 26	8	599	665	559	1,638	2	7
August 8	10	578	653	450	4,061	5	19
August 9	10	264	293	223	570	3	13
August 10	10	377	522	296	6,138	17	70